ILC VALUE ESTIMATE and METHODOLGY

(confidential details removed)

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Fermilab

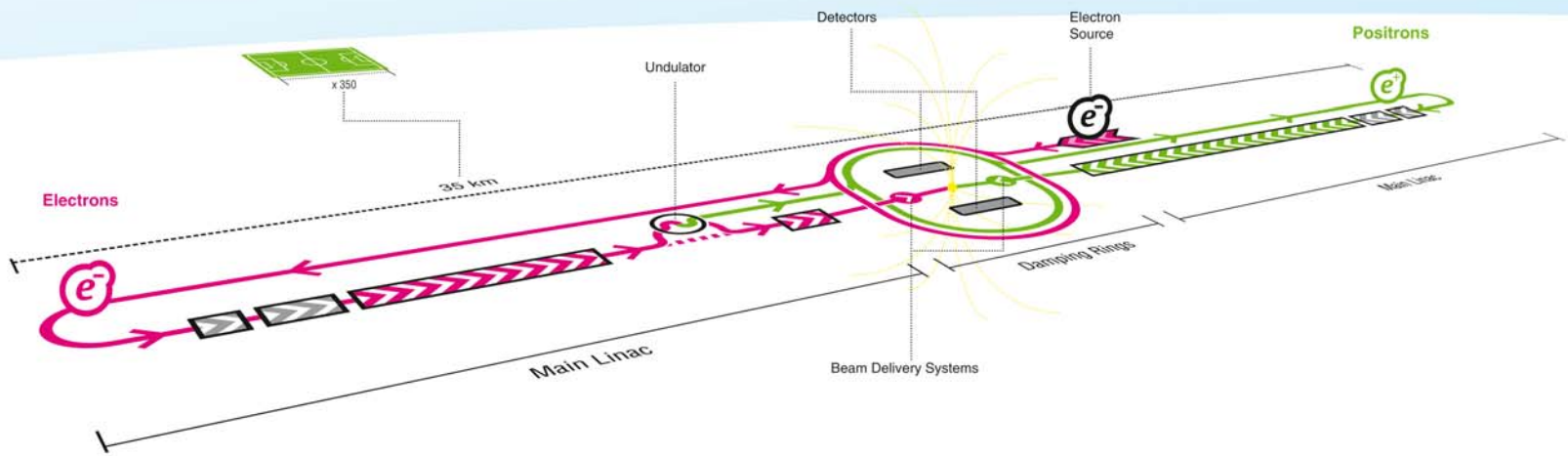
ILC-Global Design Effort

Outline

- **draft** RDR and **preliminary** value estimate
- URLs – how to find
- I will not discuss the technical aspects except where they affect estimate
- Barry Barish will present at ILC-FEST on Wed., March 7
- Marc Ross and I will follow-up Friday, March 9

- Confidentiality – still!
- International Value Estimate – what's in? what's out?
- Organization, instructions, and standards
- Process & Optimization
- Examples of Basis of Estimate
- Preliminary Value Estimate
- Characteristics of the Estimate
- Still to do…
- Lots of time for ***discussion***

The International Linear Collider



draft (still missing sections) Reference Design Report (RDR) including ***preliminary*** Value and Explicit Labor Estimates was made public in Beijing, Thursday, February 8, 2007

http://www.linearcollider.org

international linear collider

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Beijing ILC Workshop 2007, 4-7 February (Image Courtesy IHEP)

Current News

From *iTWire* 11 February 2007

International Linear Collider proposed to explore origins of universe
"An international high-energy physics research project was proposed on Thursday, February 8, 2007, at a meeting in Beijing, China. The project intends to design and build the International Linear Collider that is proposed to consist of a 30-kilometer (20-mile) linear particle accelerator..."

From *Zeit online* 10 February 2007

Wer soll das bezahlen?
"5,5 Milliarden kostet einem neuen Bericht zufolge der modernste Teilchenbeschleuniger der Welt. Deutsche Physiker würden ihn gerne nahe Hamburg aufbauen. Von Björn Schwentker..."

From *Le Figaro* 10 February 2007

Un accélérateur pour éclairer le big bang
"Le schéma technique du futur accélérateur de particules international a été présenté à Pékin. Coût estimé : 5,5 milliards d'euros..."

Features

Draft Reference Design Report Released

- Report (10MB pdf)
- Report (10MB pdf) (Mirror-Asia)
- RDR Summary (1.6MB pdf)
- Companion Document (1.5MB pdf)
- The Estimate Explained (pdf)
- ILC by the Numbers (pdf)
- More materials and images

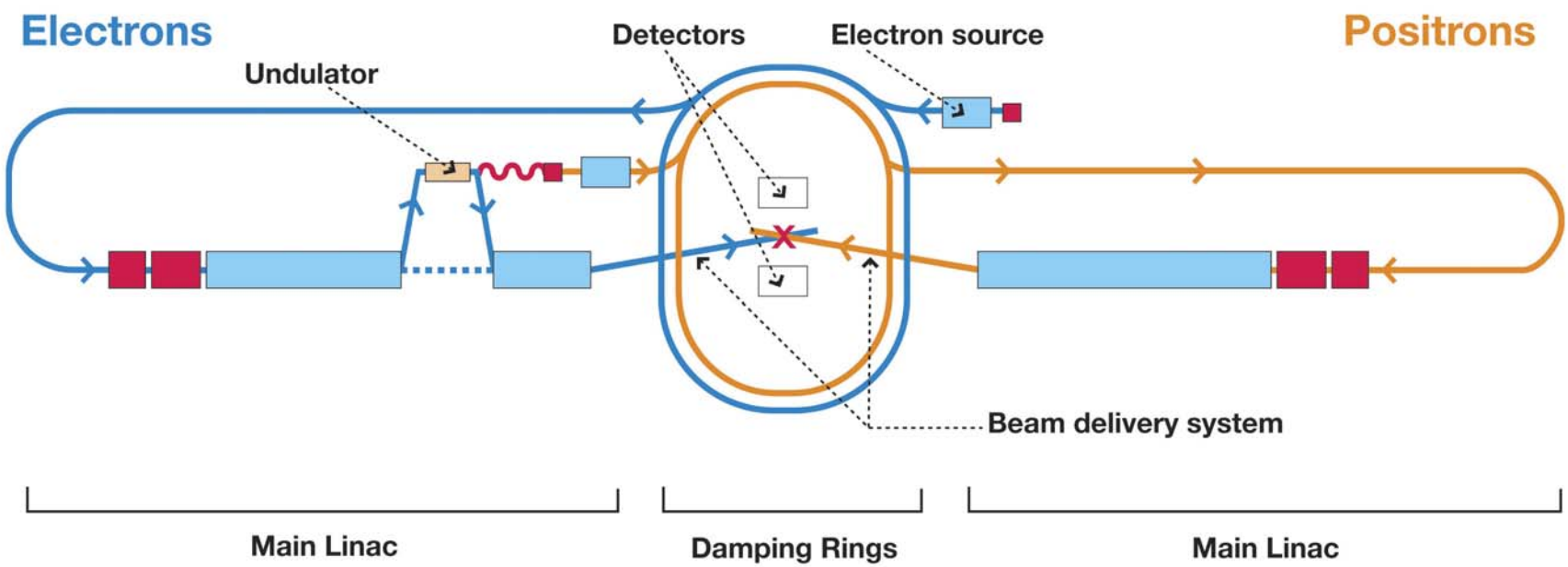
For the Press
Get additional information about the ILC at our Media Advisory page.

ILC NewsLine 8 February 2007

Ni Hao! View some highlights from the Beijing ILC Workshop.

Report, Companion Document, Graphics, and more…

ILCSC Parameters Reports (R. Heuer)



E_{cm} adjustable (scan) from 200 – 500 GeV

Peak Luminosity 2 x 10^{34} $cm^{-2}sec^{-1}$

→ $\int L dt$ = 500 fb^{-1} in 4 years

Energy stability and precision below 0.1%

Electron polarization of at least 80%

The machine must be upgradeable to 1 TeV

Removing safety margins in the energy reach is acceptable but should be recoverable without extra construction. The max luminosity is not needed at the top energy (500 GeV), however …..

The interaction region (IR) should allow for two experiments ….. the two experiments could share a common IR, provided that the detector changeover can be accomplished in approximately 1 week.

Gee Whiz (all pushing industry):

16,088 SC Cavities: 9 cell, 1.3 GHz

1848 CryoModules: 2/3 containing 9 cavities,
1/3 with 8 cavities + Quad/Correctors/BPM

613 RF Units: 10 MW klystron, modulator, RF distribution

72.5 km tunnels ~ 100-150 meters underground

13 major shafts $\geq$ 9 meter diameter

443 K cu. m. underground excavation: caverns, alcoves, halls

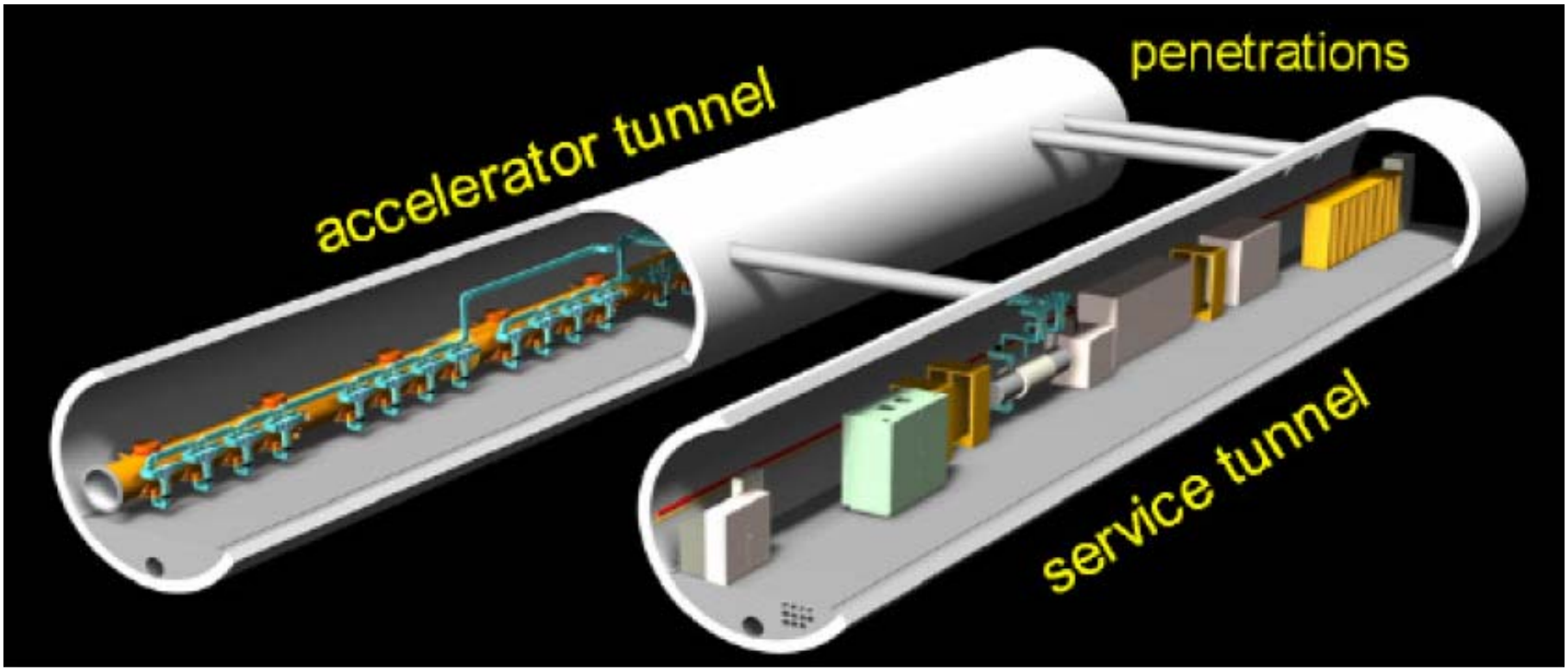
10 Cryogenic plants, 20 KW @ 4.5^{o} K each
plus smaller cryo plants for e-/e+ (1 each), DR (2), BDS (1)

92 surface “buildings” (for Americas’ site), 52.7 K sq. meters

240 M Watts connected power, 345 MW installed capacity

13,200 magnets – 18% superconducting

Main Linac Double Tunnel



- 3 RF/cable penetrations every RF Unit (3 CM = 26 cavities)
- Personnel safety crossovers every 500 m
- 34 kV power distribution

Abbreviated RDR Timeline

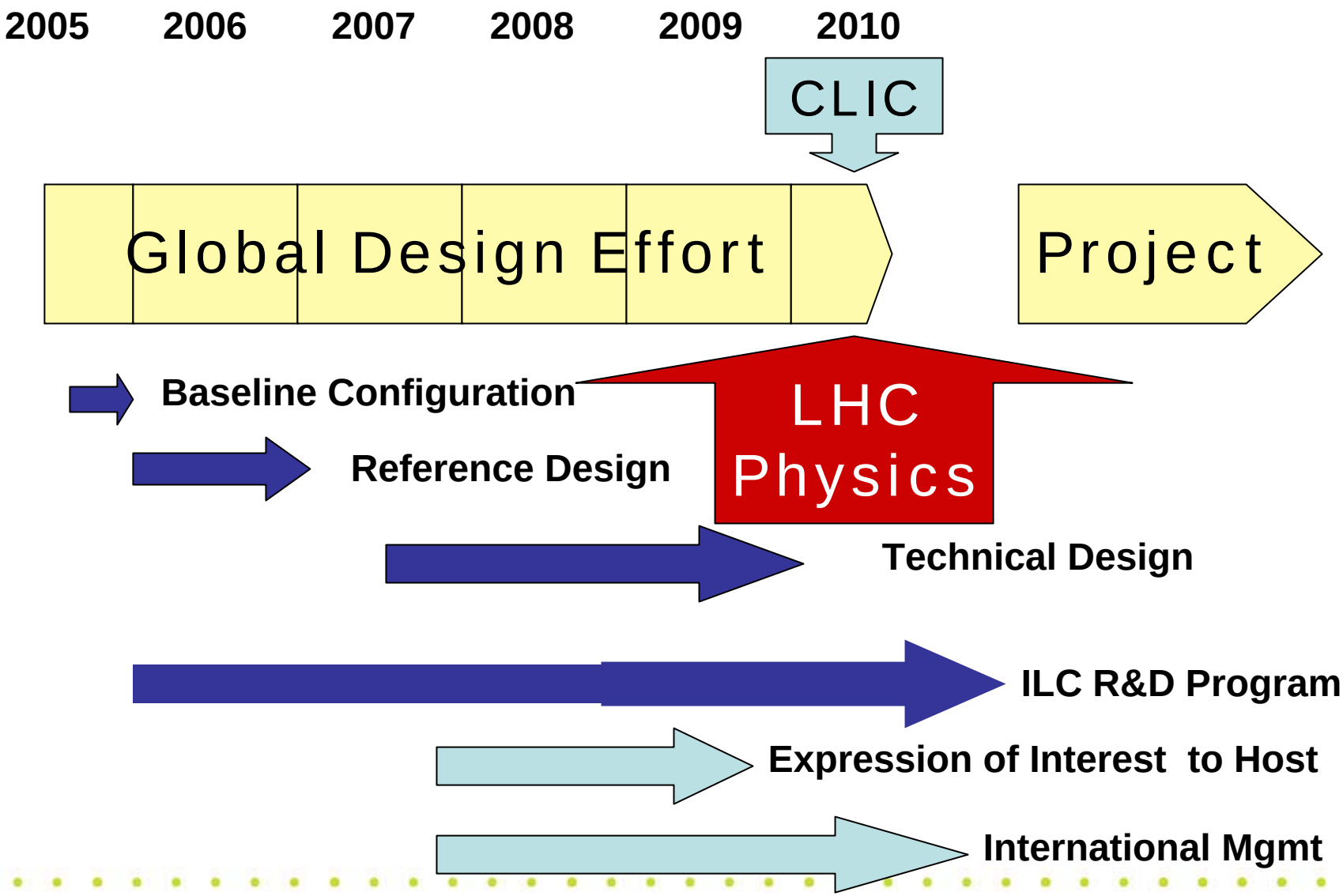
- Beijing – August 04 – ITRP recommends “cold”
- Snowmass - August 05

  prepare Baseline Configuration Document
- Frascati - December 05 – accept BCD
- Bangalore – March 06 – Design/Cost Methodology
- Vancouver – July 06 – Review Initial Cost Estimates

  cost/performance optimization & tradeoff studies
- Valencia – November 06 – Review Final Estimates
- Beijing – February 07 – release preliminary RDR

  begin Engineering Design phase

The GDE Plan and Schedule



RDR Cost Estimating

- "Value" Costing System:
  International costing for International Project
  - **Provides basic agreed to "value" costs**
  - **Provides estimate of "explicit" labor (man-hr)]**
- Based on a call for world-wide tender:
  lowest reasonable price for required quality
- Classes of items in cost estimate:
  - **Site-Specific: separate estimate for each sample site**
  - **Conventional: global capability (single world estimate)**
  - **High Tech: cavities, cryomodules (regional estimates)**
- Value is the ***least-common denominator*** among all parties, in that it is the ***barest*** cost estimate that ***any*** of their funding agencies expect. It needs translation into cost, by region.

Major Components of Cost Estimate:

- Three Site Dependent Estimates for Civil Construction, HV Electrical Power Distribution, Primary Cooling Water
  - **CERN, Japan, Fermilab (an estimate for each site)**
- Other conventional facilities estimates
  - **electrical, HVAC, cooling, fire protection, hoisting, safety**
  - **site-independent**
  - **each estimated by single region, then apply globally**
- Technical Cost Drivers: Cavities, Cryomodules, RF
  - **independent estimates from each of 3 regions**
  - **based on Industrial Studies (not yet US for Cavities/CM, US Cavities/CM estimate is an engineering model)**
  - **choose estimate derived from TESLA for VALUE**
- Other items have **single** engineering level estimates
  - **based on world-market (lowest cost) estimates**
  - **often based on prior purchasing experiences**

Scope of the Estimate

What is Included:

500 GeV machine include
- sizing to enable 1 TeV, e.g. beam dumps, BDS tunnels

tooling-up industry,
- final engineering designs, construction management

construction of all conventional
- facilities, tunnels, bldgs, etc.

construction of detector hall, shafts, assembly building, etc.

explicit labor including management & administration

What is *Not* Included:

2007 estimate, no escalation

Research & Development

prototype system tests

contingency, taxes

engineering & design that can be accomplished before construction start

surface land or underground easement costs

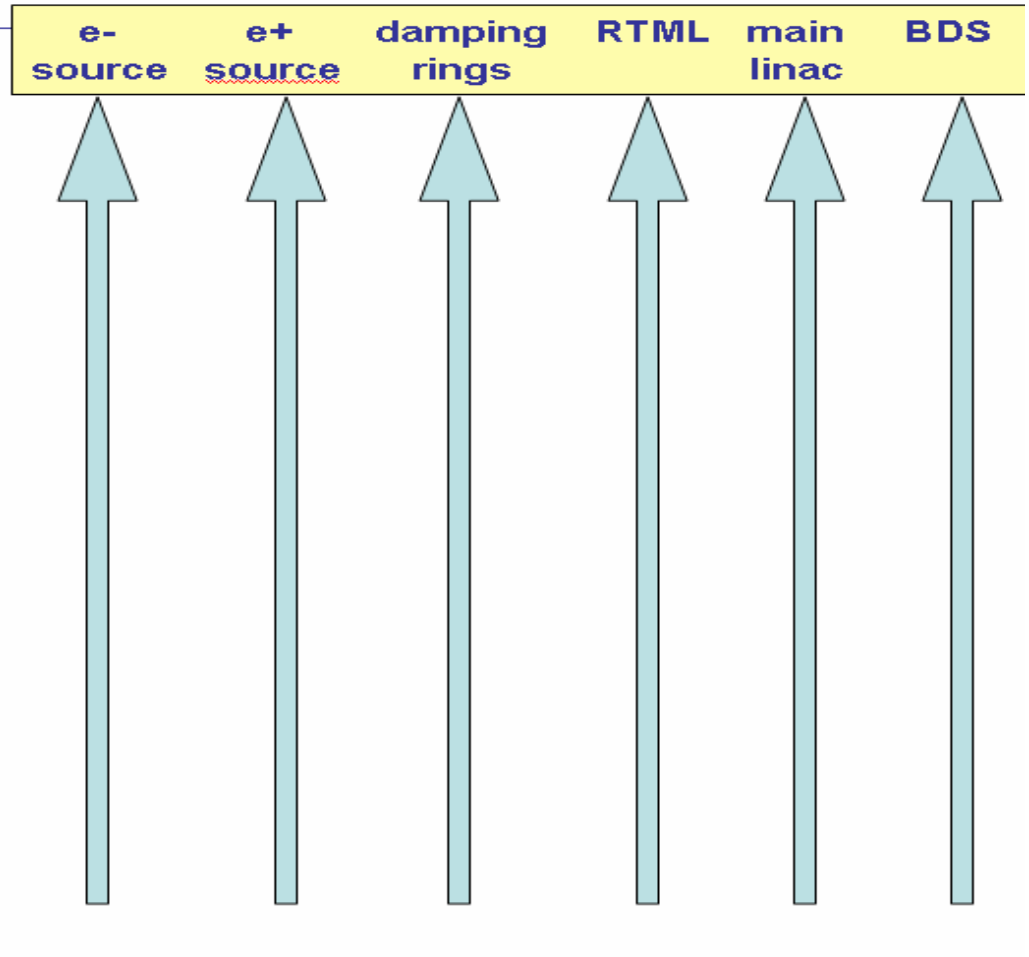
experimental detectors

commissioning, operations, decommissioning

matrix of team & responsibilities

Cost Roll-ups

Area Systems
Technical Systems
Vacuum systems
Magnet systems
Cryomodule
Cavity Package
RF Power
Instrumentation
Dumps and Collimators
Accelerator Physics
Global Systems
Commissioning, Operations & Reliability
Control System
Cryogenics
CF&S
Installation



Instructions for the RDR Cost Estimate produced by Design & Cost Board

Cost Estimating Guidelines – Bangalore, March 06

http://www-ilcdcb.fnal.gov/RDR_costing_guidelines.pdf

more detailed Cost Estimating instructions – May 06

http://www-ilcdcb.fnal.gov/RDR_Cost_Estimating_Instructions_23may06.pdf

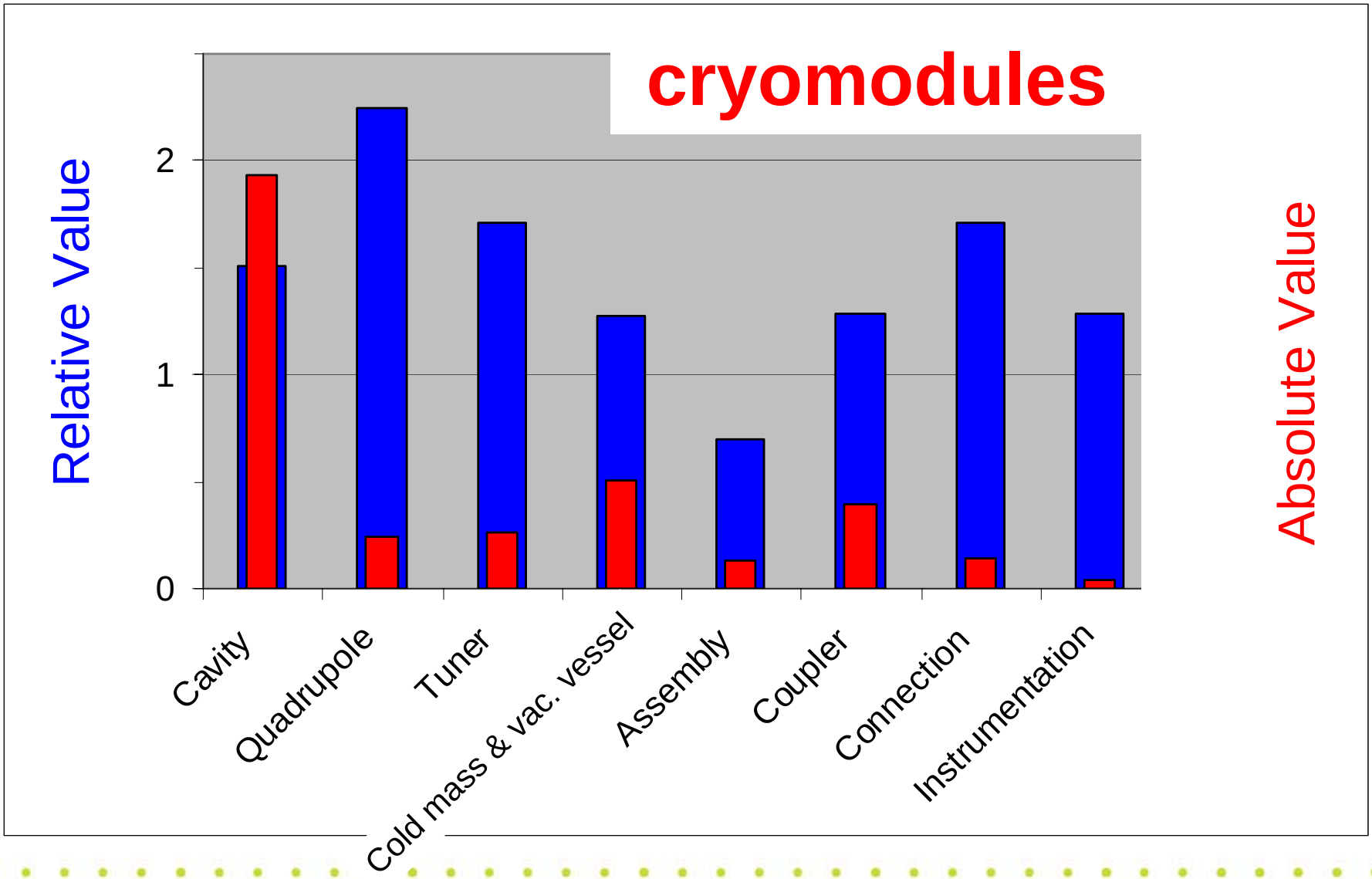
Examples of Basis of Estimate

- Cavities and Cryomodules:
  industrial studies:
    scaled TESLA, Asia + KEK experience
      Americas industrial study – in process
      engineering studies & hybrid models
- RF Power – (SLAC developed) factory model,
  industrial vendor quotes in Asia & Europe
- Cryogenics – CERN LHC plant cost model
  recent experience (FNAL quotation),
  awaiting Cornell ERL budgetary quotes

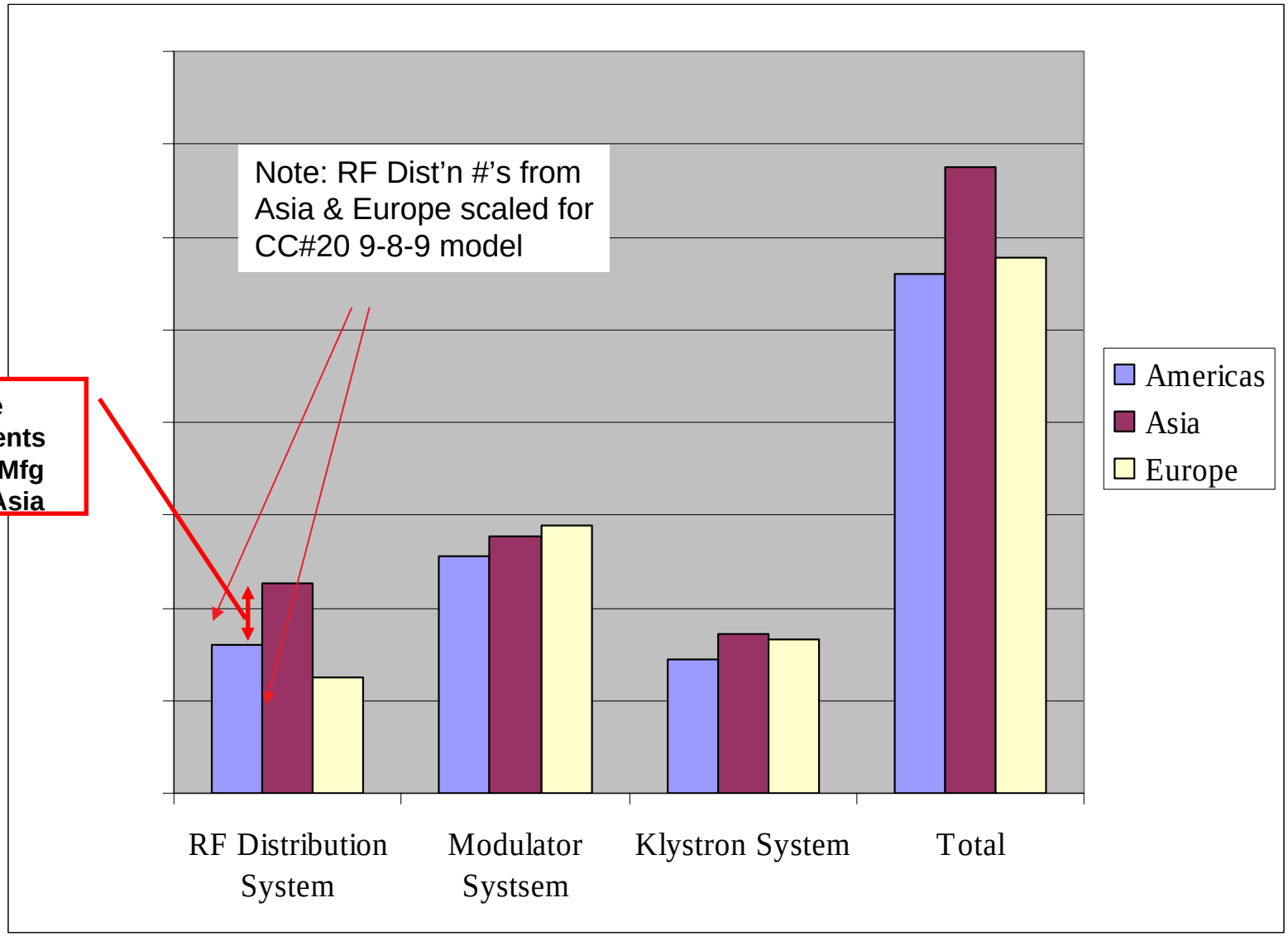
Examples of Basis of Estimate (2)

- Damping Ring RF
  - scaling KEK-B cavities & CryoModule costs
  - discussions with vendor on costs
  - for extrapolating current 500 MHz klystrons
    - to production of 650 MHz klystrons
- Conventional Magnets
  - checked eng. cost estimates for a quad series w 3 vendors (all non-US) – agree to ~ a few %
- XFEL bids will be coming in 1-1.5 years from now

American vs. European Estimate



Cost of High Level RF by Region



Confidentiality…still

Although the draft RDR with preliminary estimates have just been released,

additional backup explicit estimate data remain confidential since they are either

proprietary from industrial sources

or could influence upcoming procurements (XFEL)

I will be able to show, but not give, some of this data.

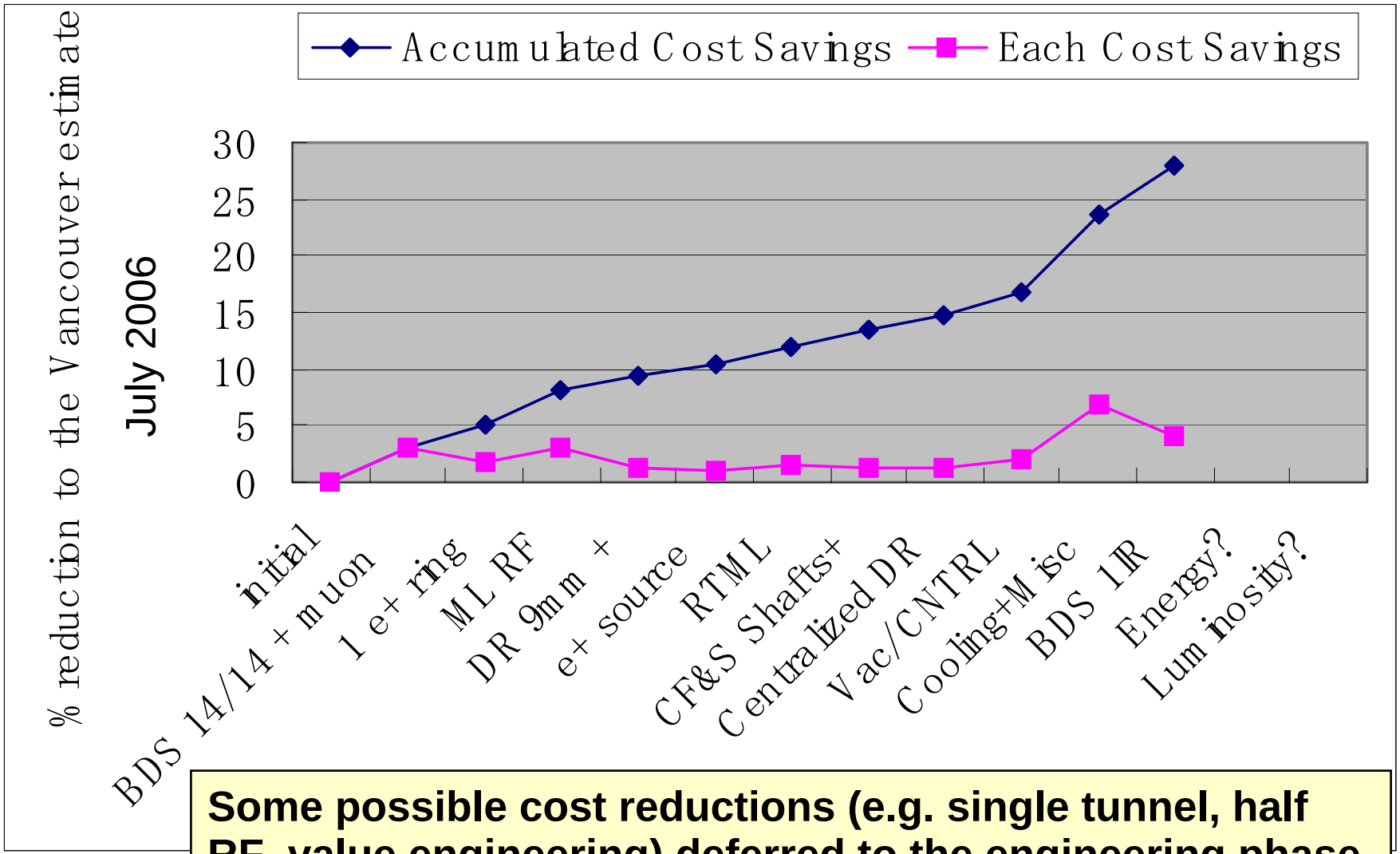
They will be marked as ***confidential*** and be removed from any copies of this presentation

Cost-Driven Design Changes

confidential

Area		RDR MB	CCR	CCB	approx. Δ$
BDS	Two 14mr IRs	supported	14	YES	
	Single IR with push-pull detector	supported	23	YES	
	Removal of 2nd muon wall	supported	16	YES	
ML	Removal of service tunnel	**rejected**			
	RF unit modifications (24 ® 26 cav/klys)	supported			
	Reduced static cryo overhead	supported	20	YES	
	Removal linac RF overhead	supported			
	Adoption of Marx modulator (alternate)	**rejected**			
RTML	Single-stage bunch compressor	**rejected**			
	Miscellaneous cost reduction modifications	supported	19	YES	
Sources	Conventional e+ source	**rejected**			
	Single e+ target	supported	*in prep*		
	e- source common pre-accelerator	supported	22	YES	
DR	Single e+ ring	supported	15	YES	
	Reduced RF in DR (6 → 9mm σ_z)	supported	*in prep*		
	DR consolidated lattice (CFS)	supported	*in prep*		
General	Central injector complex	supported	18(19)	YES	

Evolving Design → Cost Reductions



Some possible cost reductions (e.g. single tunnel, half RF, value engineering) deferred to the engineering phase

explicit labor (person-hours)

- Implicit labor for producing components, civil construction, etc., is included in the purchase price.
- Explicit labor is estimated separately from component costs. It may be provided by the ILC collaborators as in-kind contributions, drawn from existing laboratories with their own personnel and budgets (e.g. design, testing, supervision, etc.) , or may be purchased from industrial firms (e.g. trades people: riggers, millwrights, electricians, etc. for installation).

RDR Design & "Value" Costs

The reference design was "frozen" as of 1-Dec-06 for the purpose of producing the RDR, including costs.

It is important to recognize this is a snapshot and the design will continue to evolve, due to results of the R&D, accelerator studies and value engineering

The value costs have already been reviewed twice

- **3 day "internal review" in Dec**
- **ILCSC MAC review in Jan**

Σ Value = 6.65 B ILC Units

Summary

RDR "Value" Costs

Total Value Cost (FY07)

4.87B ILC Units Shared

+

1.78B Units Site Specific

+

13.0K person-years

("explicit" labor = 22.2 M person-hrs @ 1,700 hrs/yr)

1 ILC Unit = $ 1 (2007)

1 ILC Unit of Value =

$ 1 = 0.833 € = 117 ¥

January 1, 2007

Remember:

VALUE ≠ COST

for comparison

ILC: 6.7 B ILC Units (2007$) + 13,000 person-years

TESLA: 3.1 B € (2000) + 6,900 person-years

	TESLA TDR / M€	Scaled TESLA TDR / M$	ILC RDR / M$	Difference / M$
Total Cost	**3136**	**5018**	**~6500**	**~1500**
Civil Facilities	676	1082	2437	1355
Underground Buildings	383	613	1070	457
Surface Buildings	44	70	168	98
Consultant Engineering	10	16	160	144
Power Distribution	34	54	275	221
Water Cooling	70	112	374	262
Cryogenic System	162	260	567	307
Cryo Plant*	12 x 11	12 x 17	10 x 34.3	139

*TESLA: 6 x 4.3 kW @ 2 K

ILC: 10 x 3.5 kW @ 2 K

XFEL: 2.45 kW @

The difference is primarily in conventional facilities

VALUE Estimate Summary – ILC Units

VALUE	site-specific	shared	total
Asia	1.6 B	4.9 B	6.5 B
Americas	1.9 B	4.9 B	6.8 B
Europe	1.8 B	4.9 B	6.7 B
Average	1.8 B	4.9 B	6.7 B

not too different!

plus 13 K person-years of explicit labor

(~ 2,000 persons/year over 7 years constructio

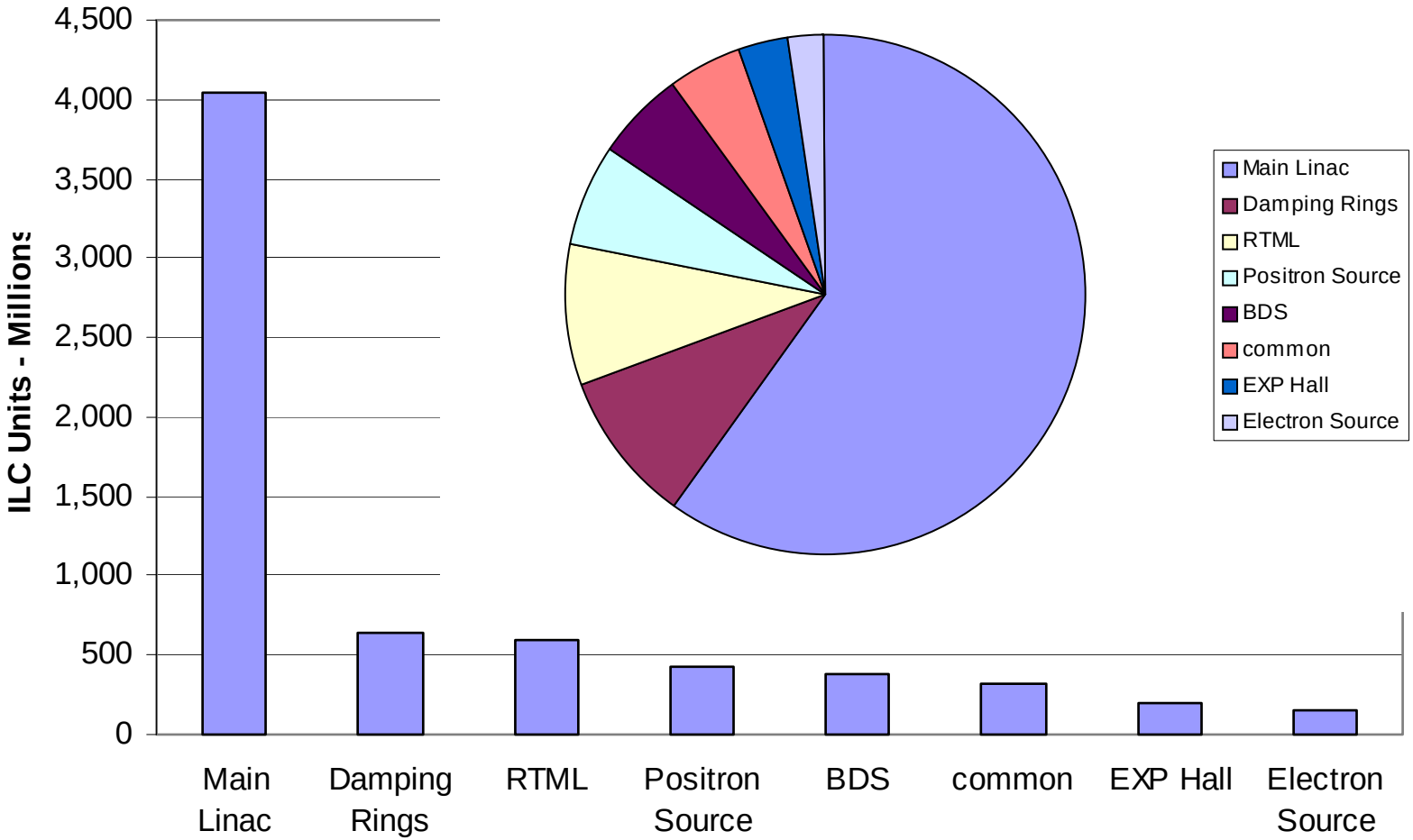
(= 22 M person-hrs @ 1,700 hrs/yr)

site-specific: civil engineering, HV electrical power, and primary cooling water systems.

(use Americas' estimates in illustrations below)

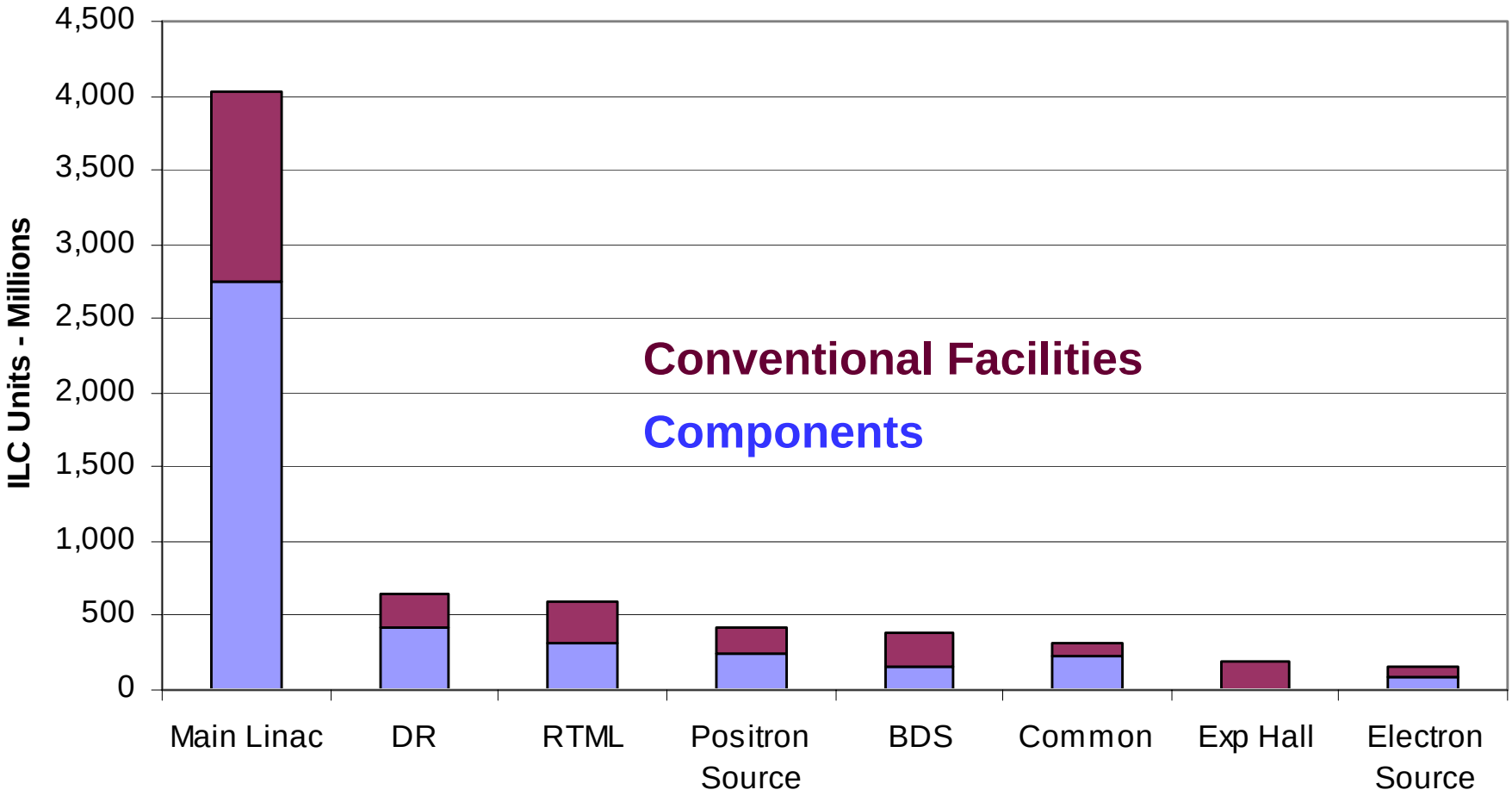
ILC Value – by Area Systems

includes CF&S in each AS total

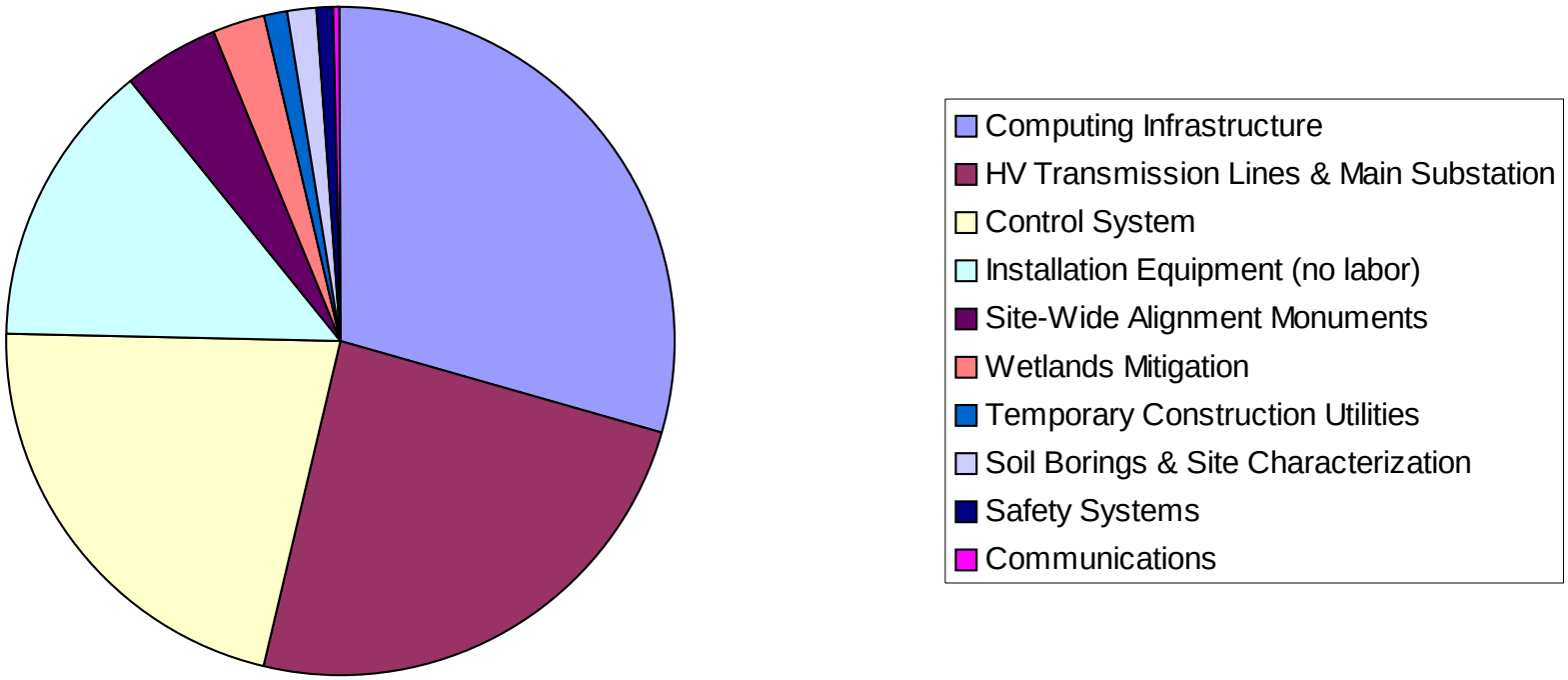


see next page for definition of “common”

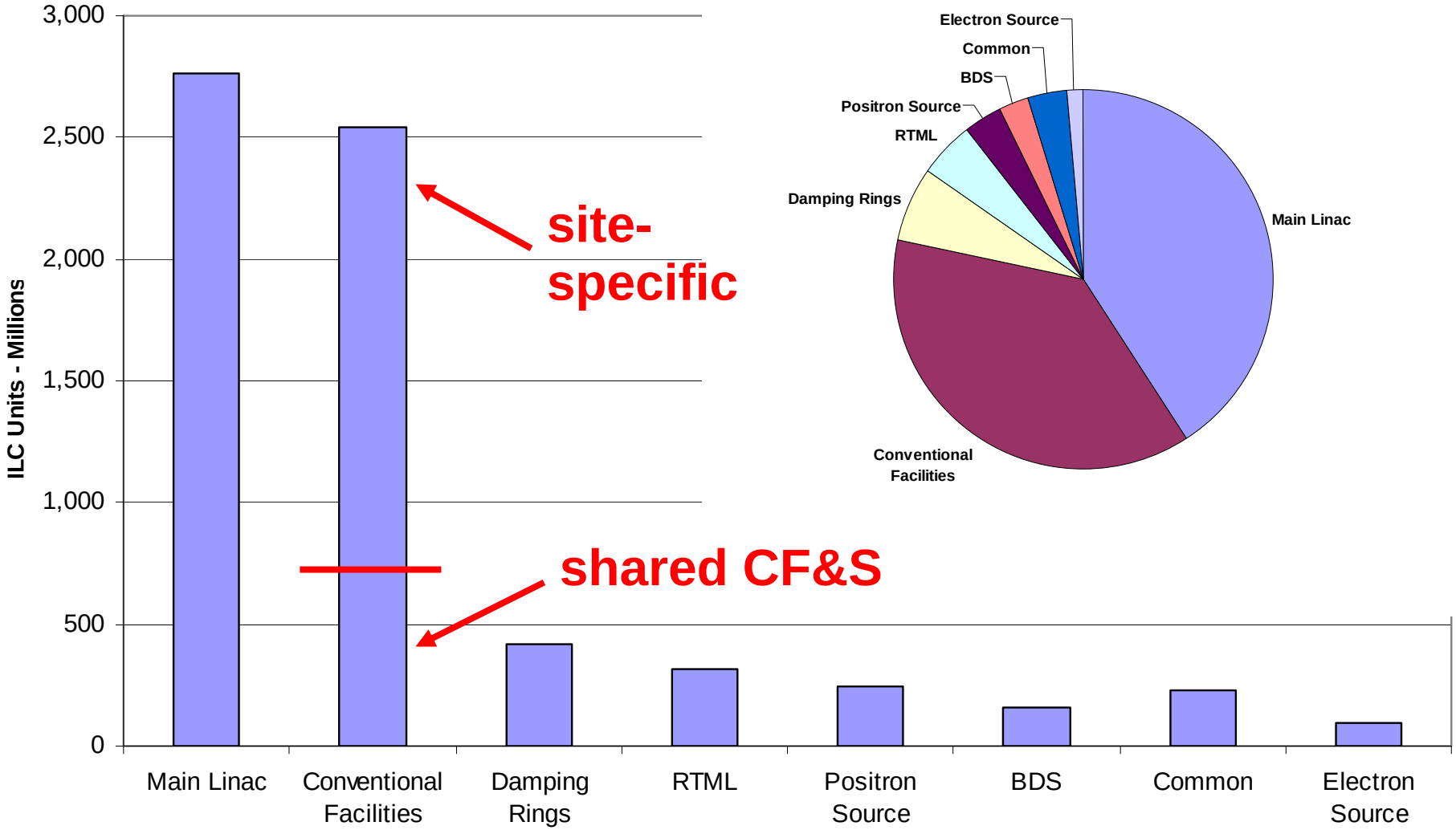
ILC Value – by Area Systems



“common” includes:



Value – CF&S + AS (non-CF&S)



ILC Value – by Global & Technical Systems

confidential

Installation counted mostly as in-house labor

Area vs. Global/Technical Systems

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What's in Conventional Facilities?

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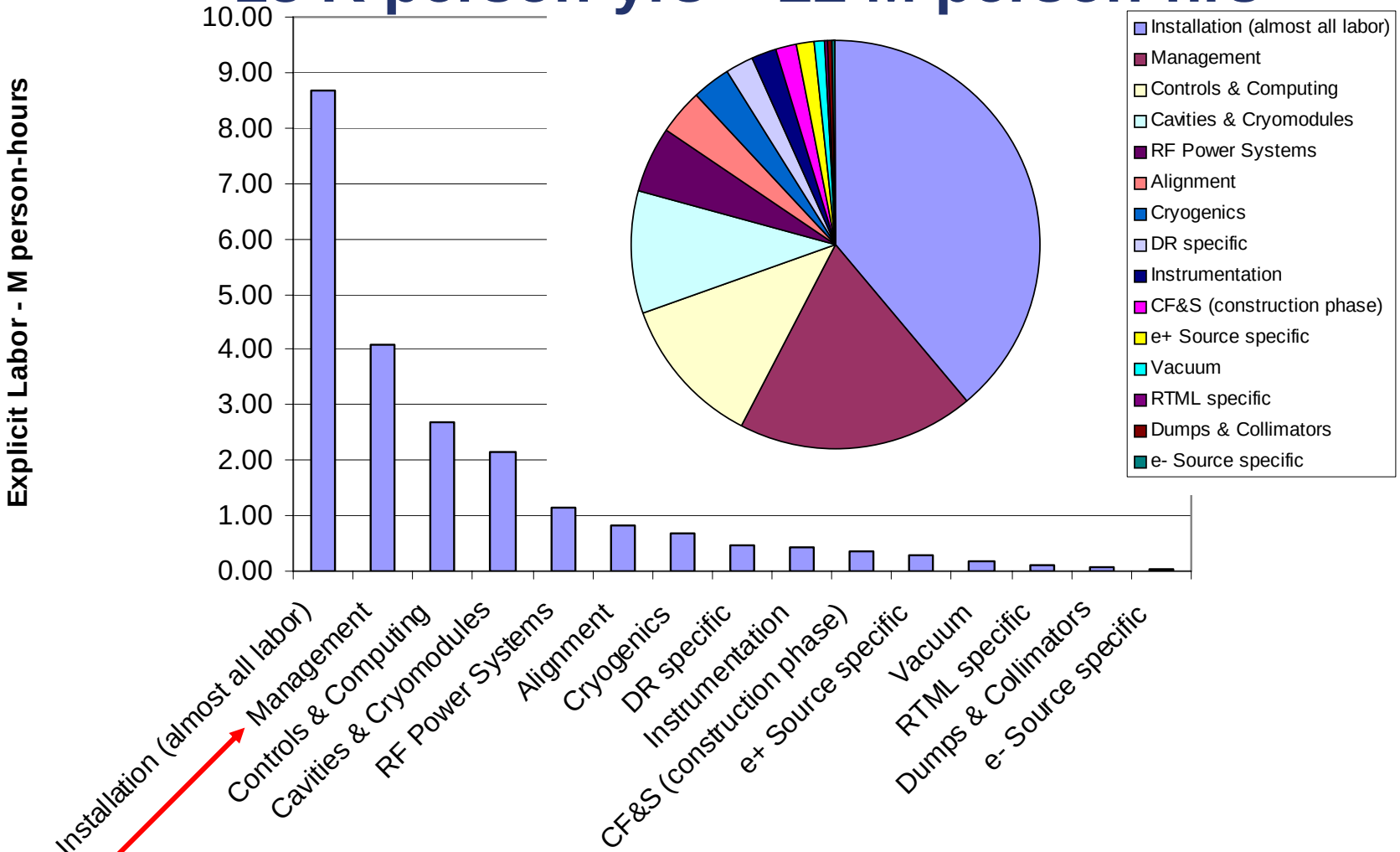
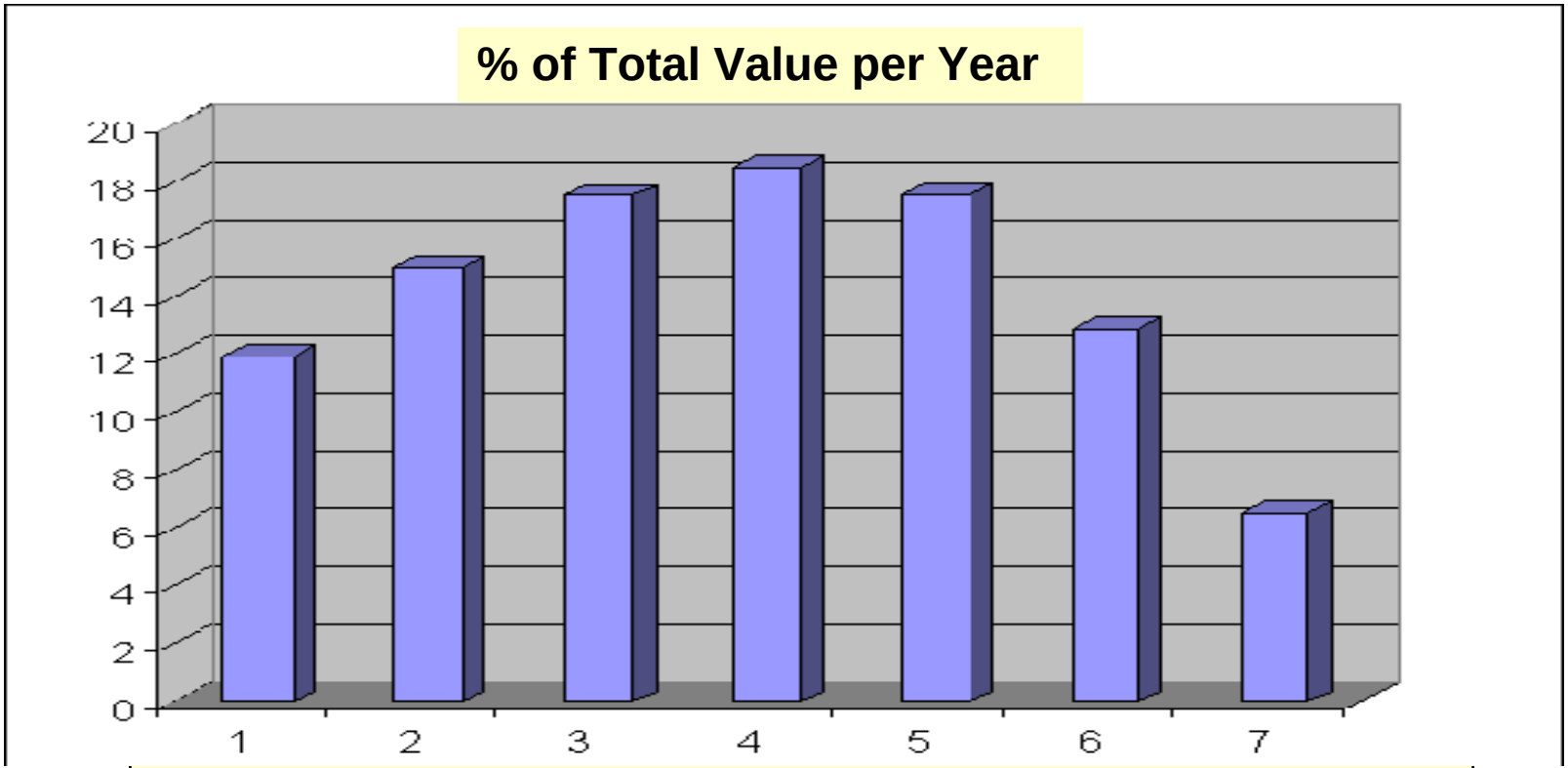
for Americas' Site
2006 Value for illustration
(not escalated)
shared
site-specific

plus Explicit Manpower = 13 K person-yrs = 22 M person-hrs



* "management" includes personnel in "overhead sections"

Value Funding Profile



We are not using integrated cost/schedule tools yet; but it appears feasible to develop a realistic funding profile

still only a Preliminary Estimate

- need: many checks of value estimate
  - explicit labor is ***very*** preliminary => needs work
  - uncertainties and risk analysis:
    - uncertainties in costs and quantity discounts
    - technical risks – e.g. gradient, underground
    - futures: copper, construction, inflation, etc.
- International Review – April *or so*…
  - commissioned by FALC and ILCSC
- complete Reference Design Report & Estimate
  - and submit to ILCSC in July
- translate into US DOE Metrics

end of my presentation

many thanks to
Barry Barish & Wilhelm Bialowons
from whom I appropriated many slides

questions, comments, suggestions?